Customer No.: 31561
Application No: 10/064,095
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Specification Amendment

Please respectively replace paragraphs [0004], [0034], [0035] of the specification with the following paragraphs:

[0004] A photodiode image sensor has been commonly used as an image sensor device. Typically, the photodiode at least includes a reset transistor and a sensing region formed by a diode. In the case that a diode formed by a N type doped region and a P type substrate is used as a sensing region, to operate the photodiode image sensor, ~~applies~~ a voltage is applied to a gate of the reset transistor in order to charge a junction capacitor of an N/P diode after the reset transistor is turned on. Once the junction capacitor reaches a desirable level, the reset transistor is turned off to reverse the N/P diode and thus form a depletion region. When the N/P sensing region is exposed to light, electrons and holes generated during exposure are separated by an electric field of the depletion region, ~~t~~The electrons then move~~ing~~ toward the ~~P type substrate~~N-type doped region to lower the voltage~~, causing the voltage drop~~ of the N type doped region, and the holes ~~leaving~~leak through the P type substrate. At this time, if one transistor transmits the electrons of the N type doped region to a bus line and if the charges generated by the light exposure are also directly transmitted to the bus line without any amplifier, such an image sensor is called a passive pixel photodiode. If the N type doped region is connected to a source follower, formed by a transfer transistor, then the larger current provided by the source follower helps to quickly charge/discharge at the bus line, to stabilize the voltage at the bus line and to minimize the noise. Such an image sensor is called an active pixel photodiode.

[0009] It is one object of the invention to provide a CMOS image sensor device and a process for producing the same. It is an important feature of the invention to form a ~~buried contact~~ local interconnect to connect a source region of a reset transistor and a gate of a source follower, that covers not only a photodiode

node but also covers a boundary between the photodiode node and a field oxide in a photodiode sensing region so as to protect them from being damaged during subsequent processes.

[0011] In one aspect of the present invention, a CMOS image sensor device is provided. The device of the invention includes a substrate, a photodiode sensing region, a reset transistor, a source follower transistor and a ~~buried contact (BC)~~local interconnect. The substrate has an isolation structure that defines an active region. The photodiode sensing region is located in the substrate, and the reset transistor is located on the active region of the substrate and has a source region partially connected to the photodiode sensing region. A first end of the ~~buried contact~~ local interconnect is located on the substrate between the photodiode sensing region and the reset transistor, and extends over the isolation structure to cover the periphery of the isolation structure and electrically connect the source region of the reset transistor. A second end of the ~~buried contact~~ local interconnect is located on the active region of the substrate to be used as a gate of the source follower transistor.

[0012] In the present invention, the ~~buried contact~~ local interconnect is formed to cover the whole photodiode sensing region including the periphery of the isolation structure adjacent to the photodiode sensing region. With the use of such a ~~buried contact~~ local interconnect the isolation structure can be protected from being damaged during subsequent processes, the occurrence of the dark current can be minimized, and the image sensor performance and the exposure time can be increased. Furthermore, since the ~~buried contact~~ local interconnect connects the source region of the reset transistor to the gate of the source follower transistor, no additional contact or conductive line is needed. Therefore, the level of device integration can be increased.

[0014] While the gates for the reset transistor, the source follower transistor and the output selection transistor are formed, a ~~buried contact~~ local interconnect is formed to connect the gate of the source follower transistor to the source region of the reset transistor. One end of the ~~buried contact~~ local interconnect covers a photodiode node and the periphery of the active region of the photodiode (the periphery of the isolation structure, i.e. the bird's beak area). Therefore, damage on the periphery of the photodiode node during the subsequent processes such as ion implantation, etching of the spacer, or plasma etching can be prevented. Besides, the occurrence of the dark current is minimized and white pixels can be prevented from being formed in arrays of the CMOS image sensor device.

[0015] Furthermore, because the source of the reset transistor is electrically connected to the gate of the source follower transistor by means of the ~~buried contact~~ local interconnect no additional contact or conductive line is needed. Therefore, the level of device integration can be increased.

[0024] With reference to Fig. 2, an image sensor device 200 includes an active region 202, an isolation structure 204, a photodiode sensing region 206, conductive regions 208, 210, 212, and contacts 214, 216, 224. The isolation structure 204 can be a field oxide, for example. The photodiode sensing region 206 is located under a portion of the isolation structure 204. The photodiode 206 consists of a substrate and a doping region having dopant type different from that of the substrate. When a P type substrate is used, the doping region is doped with N type dopants. When an N type substrate is used, the doping region is doped with P type dopants. In this embodiment of the present invention, a P type substrate with a deep N type well is used. The portion of the conductive layer 208 which traverses a part of the active region 202 serves as a gate of the reset transistor 218. The portion of the conductive layer 210 which traverses a part of the active region 202 serves as a gate of the output selection transistor 220. One end of the conductive layer 212 electrically couples with a source of the reset transistor 218 through the contact 224. The conductive layer 212 extends ~~to~~over the

isolation structure 204 of the active region202 to cover the isolation structure 204, specifically, the periphery of the isolation structure 204. The other end of the conductive layer 212, which extends over the other portion of the active region 202, serves as a gate of source follower transistor 222. With the conductive layer 212 capping the isolation structure 204 of the photodiode 206, the isolation structure 204 can be protected from being damaged in sequential processes, thereby reducing the dark-current effect and increasing the image sensor performance and the exposure time.

[0034] In the above embodiment of the present invention, while the gates for the reset transistor, the source follower transistor and the output selection transistor are formed, a ~~buried contact~~ local interconnect contact is formed to connect the gate of the source follower transistor to the source region of the reset transistor. One end of the ~~buried contact~~ local interconnect contact covers a photodiode node and the periphery of the active region of the photodiode (the periphery of the isolation structure, i.e. the bird beak area). Therefore, damage on the periphery of the photodiode node during the subsequent processes such as ion implantation, etching of the spacer, or plasma etching can be prevented. Besides, the occurrence of the dark current is minimized and white pixels can be prevented from being formed in arrays of the CMOS image sensor device.

[0035] Furthermore, because the source of the reset transistor is electrically connected to the gate of the source follower transistor by means of the ~~buried contact~~ local interconnect contact, no additional contact or conductive line is needed. Therefore, the level of device integration can be increased.